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Blue Urbanism

An Insight of Navigating Climate Change in Humid Tropical Cities in Brunei Darussalam

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Abstract – Coastal cities are most at risk to rising sea levels and increased precipitation. This is however the Climate Change Scenario forecasted for the humid tropical region in the IPCC's Sixth Assessment report. As standard engineering (grey) solutions are prohibitive in many developing countries due to financial and technical limitations, this paper proposes an adaptive blue approach. It shares insights from Brunei, where the old capital was a city built over water. It also presents findings from a preliminary survey to gauge the public's views on a set of blue urbanism proposals. The study found positive support for the proposals in general. In particular, there was strong support for: (i) incorporating 'green' features into the urban complex; (ii) more public spaces where people could learn about their cultural heritage; and (iii) participation in the life and management of the city. There is however (iv) less enthusiastic response to blue features. The paper discusses viability of the blue urbanism approach vis-à-vis cultural and contextual changes. The insights presented could be useful to other coastal cities in the region.

Keywords: *blue urbanism, coastal cities, cultural heritage, sea level rise.*

I. INTRODUCTION

The climate in countries and cities has been observed to be changing over the past five decades or so[i]. There are clear changes in regional and global hydrometeorological circulation patterns and characteristics, as well as increases in ocean volume from melting glaciers (Oppenheimer et al., 2019). The 6th Assessment Report of the IPCC, Working Group (WG) 1 (Physical Science Basis) stated that it is "virtually certain that Global Mean Sea Level (GMSL) will continue to rise until at least 2100" (IPCC, 2021: 1216). It estimated GMSL to be 0.4-0.8 m higher by the end of century, with extreme sea levels affecting coastal areas 20-30 times more frequently by the midpoint in 2050. Precipitation is expected to increase in the equatorial Pacific, monsoonal regions and high latitudes. Tropical cyclones could increase by 7% per 1°C rise in global average temperature, which the international community aims to keep within 2°C above pre-industrial level. The anticipated changes due to Climate Change (CC) do not bode well for coastal cities, particularly in the humid tropical region, where rainfall is generally high

and intense. Presently, a number of cities are already sinking due to a combination of natural and anthropogenic subsidence (Oppenheimer et al., 2019; Triana & Wahyudi, 2020; Wu et al., 2022). This would heighten their exposure to sea level rise (SLR).

In the modern era, urbanization has relied on science and technology in analysis, planning, development and governance. This has resulted in the growth of cities in terms of population, extent and economy, and sustain them. However, this continual transformation of the natural environment has altered environmental conditions, including local and regional climate (Dou et al., 2013). Rising concerns over the negative consequences of modern development eventually led to United Nations appointing a commission to study emerging issues, which culminated with the publication of "Our Common Future" (WCED, 1987) and the UN Conference on Environment and Development (UNCED) at Rio de Janeiro in 1992, where 178 nations agreed to adopt Agenda 21, a set of goals and objectives to steer global development towards a sustainable path. At the turn of the century, this was replaced by the Millennium Development Goals, which was succeeded in 2015 by the 2030 Agenda for Sustainable Development. Of the 17 Sustainable Development Goals (SDG), 11 and 13 address "sustainable cities and communities" and "limit and adapt to CC" respectively.

Modern cities are inherently unsustainable, due to their considerable ecological footprint. The Sustainable City (SC) concept is difficult to define clearly in practice and therefore a variety of interpretation exists (Afanasyeva et al., 2020). They tend to be isolated and relatively small-scale projects due largely to the high costs and technical expertise required to design, build and sustain them. UN-Habitat conducted an assessment on the cost implication of SDG 11 and found that they range from USD 20-50 million for small cities in developing countries, to USD 140-500 million for medium-sized developing cities (e.g., in Colombia, India or Bolivia) and USD 600-5,000 million for large developing cities (e.g., Kuala Lumpur or Bogota) (Kamiya et al., 2020; Sharif, 2023). The ASEAN Sustainable Urbanization Strategy (ASUS), an ASEAN-Australia project under the Master Plan on ASEAN Connectivity (MPAC), aims to accelerate the process of sustainable urbanization in the region. At the end of its first phase (2020-2022), although the project involving eight cities was assessed t be largely successful in achieving its objectives, the lack of donor funding for implementation was highlighted as "a serious challenge" (Kirkemann, 2023: 33). The BIMP-EAGA Green Cities Initiative[ii] which began in 2016 faced similar challenges.

ACADIS (2022), a private company that specializes in sustainable designs periodically publishes a SC Index, which is evaluated on three 'pillars' (planet, people, and profit) that mirrors the triple goals of Sustainable Development. The current list has Oslo as the overall leader and also top of the 'planet' category, while Glasgow and Seattle lead in the 'people' and 'profit' lists respectively. The connection between SC and financial and technical capability is evident. Singapore is the only Southeast Asian country that features in ACADIS's list. In the 2021 July-August issue of "The ASEAN: Road to Sustainable Cities", the Executive Director of UN-HABITAT made a profound statement: "How we plan and anticipate urbanization shape development trajectories and lives" (Sharif, 2021: 8).

This paper takes a proactive and pragmatic approach to addressing the specter of CC, given the financial and technical barriers that confronts many cities in the developing world. It presents insights from Brunei on a viable adaption strategy for coastal cities in the humid tropics based on the fact that capital of Brunei was once a city built over water and therefore, well adapted to the world that CC would reproduce for many coastal cities before sedimentation filled in the estuaries. The paper also gauges the public's views on this strategy through a questionnaire survey. The results are discussed in relation to the viability of this response to CC vis-à-vis changing environment and culture.

II. METHODOLOGY

Although the IPCC regards SLR as 'almost certain', there are uncertainties in the actual degree. Azran et al. (2023), using the Couple Model Intercomparison Project Phase 6 (CMIP6) model under a 1.5°C and 2.0°C scenario, forecasted a SLR of 0.8 m for East Malaysia and 0.6 m for the Sulu Sea by 2100. In contrast, Fu et al. (2019) estimated SLR rate of 4.42 mm/year in the South China Sea (SCS) by analyzing sea level anomalies (SLA) from satellite altimetry data (1993-2016), suggesting a rise of about 0.4 m by 2100. Liu et al. (2021) however concluded that SLR estimation derived from satellite altimetry is accurate only in the short-medium term (12-36 months). This is at the lower limit of the IPCC (2021) forecast. Using the dynamic downscaling method to improve spatial variability, Zhang et al. (2023)

found (i) a decrease in dynamic sea level (DSL) in central and southeast SCS, but (ii) an increase in coastal DSL, which is dominated by local thermosteric effect, i.e., heating. The context for the study could therefore be summarized as: (a) almost certain SLR of 0.4-0.8; (b) high variability is sea level in humid tropical coasts; (c) increased frequency of extreme sea level events; (d) increase in rainfall. The last point is corroborated by local climate data from the Brunei Meteorological Department (Hassan & Yong, 2023). Figure 1 shows the conceptual framework of this paper. Coastal cities have three options to address CC. Firstly, they could try to contain the rising sea and increased rainfall, and higher wind and wave energy using modern engineering (grey) solutions, while controlling emissions and managing impacts. This is the main approach for cities with the necessary technical and financial capacity. The second option is to cope with the impacts (floods, disruption to life and economy, etc.) as and when they occur. This is likely to be a common response for many cities that lack the capacity for technical response. The third option would be to embrace the change and adapt to the new environment, referred to as Blue Urbanism in this paper.

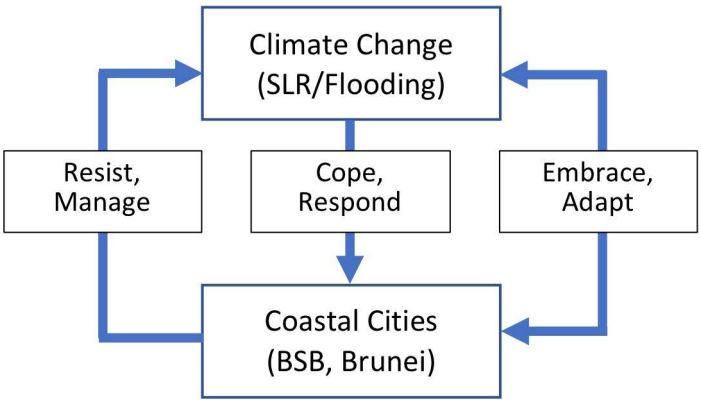


Fig. 1. Conceptual framework
Source: Authors (2024)

A. Blue Urbanism

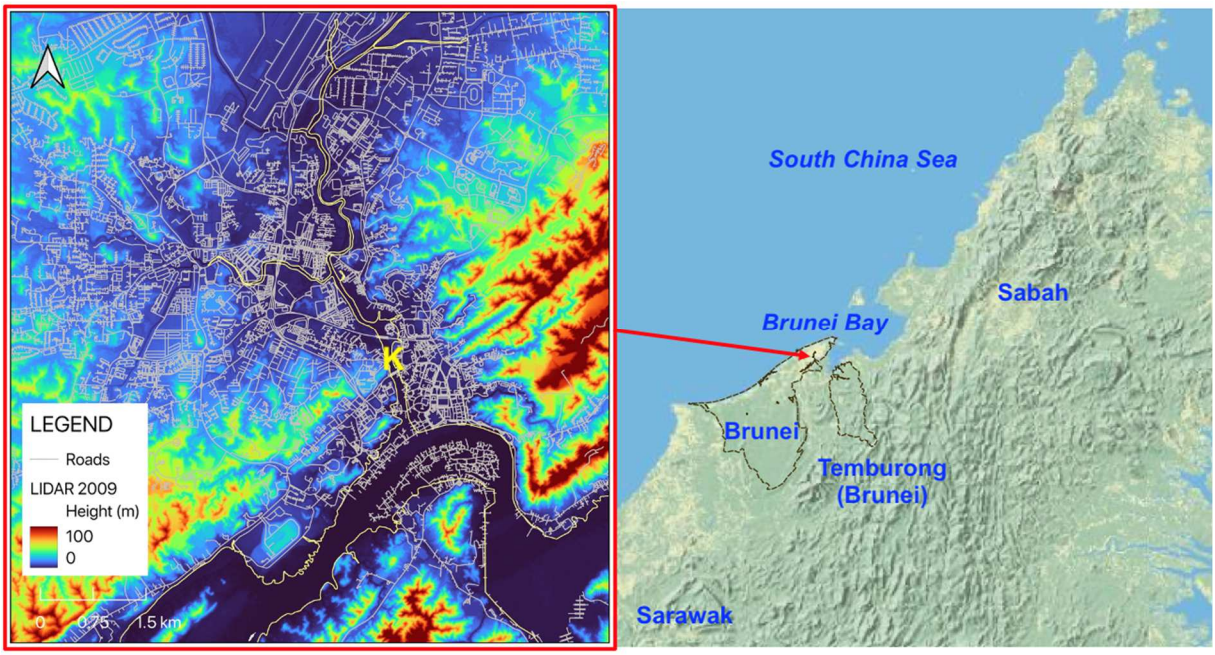
The term Blue Urbanism is attributed to urban planner, Timothy Beatley[iii], known for his work on Biophilia[iv]. It involves integrating the urban and water environments in an ecological, self-sustaining and regenerative organisation (Beatley, 2014; 2021). It shares the same ecological paradigm as ecocities (Dou et al., 2013; Saad et al, 2017) and arcology (McCullough, 2012; Soleri, 1969; Yong, 2022), but applied to urban planning in the coastal environment. Pasquero & Poletto (2012; 2023) explored architecture in the same paradigm using Artificial Intelligence in their ecoLogicStudio. In their review of the status of research on urban green and blue infrastructure (GBI) in developing countries (2015-2019), de Macedo et al. (2021) found rising interest in the Global South, with Chinese cities accounting for the largest share of research works. They focused mainly on finding innovative solutions to urban issues or on low-impact development strategies. GBI could be applied in a multi-scalar, multi-dimensional, and multidisciplinary framework (ibid.). The situation in the UK appears to be less promising with few examples of truly purposefully designed GBI, despite a strong 'policy pull', ample proof-of-concept evidence, and cross-sectoral stakeholder support (Evans et al., 2019). Instead, the proliferation of artificial structures in the marine environment has resulted in an 'ocean sprawl'. The researchers advised that benefits of GBI should be presented in ways that make sense to planners and decision-makers. To this end, Alves et al. (2019), presenting their case on Blue-Green-Grey infrastructure (BGGI) in flood risk management, stressed that the multiple co-benefits offered should be highlighted, including using quantitative evidence to show why they ought to be preferred over standard grey infrastructure.

Logically, there are three options to transport infrastructure design in low-lying areas in a SLR scenario: (i) raise it above flood levels, i.e., elevated road sections or bridges; (ii) use roads that float; or (iii) develop a safe, comfortable and reliable water transit system. Apart from the first option, the latter two require thinking outside the box of the modern (grey) development paradigm. Transport and mobility are essential to the life and economy of a city. It is the main infrastructure upon which the rest of the urban complex and life within and without are interconnected. Being self-contained is another aspect of climate resiliency. Urban design should consider localized or distributed modes of supply of

water, energy, electricity, and food, as well as in waste management. Ecological urbanism, which underlies BGI, promotes regenerative processes locally that recycles wastes and by-products into new products of value. Understanding BGI and BGGI from the perspective of its underlying complex systems ecological paradigm, it would become apparent that people and environment are capable of finding solutions organically because of the system's capacity for self-organization and self-regulation (Pasquero & Poletto, 2012). However, modern development paradigm breaks apart traditional social-cultural structures (Yeoh, 2021). In an ecological paradigm, people are considered an integral part of the urban ecosystem. Therefore, urban structures that break social-cultural relations would stifle urban interaction and hence, vibrancy. Consequently, the city would decay and degrade culturally and environmentally over time (Soleri, 1969). Blue Urbanism, like its related concepts based on BGI and BGGI, places great importance on the interest and priorities of the denizens. A people-centered city should meet these primary human needs of safety, health-promoting, liveliness, and sustainability (Gehl, 2010). According to Sadowski (2023), society is more likely to reconnect with traditional cultures than adapt to new ones. Referring to Konrad Lorenz's notion of the 'layered man', he emphasized the need for a philosophical consideration on the needs of the populace in the urban planning and governance.

B. Bandar Seri Begawan (BSB)

The capital city of the Brunei Sultanate until as recently as the early 20th Century was located within the Sungai Brunei estuary. A British engineer, Frank Nestle-Butterworth, described it as a city built over water where the people lived 'a semi-aquatic life' and 'everything had been adapted to life over water' (Blundell, 1923: 201). Under the British Residency (1906-1959), a new capital was established on the north bank as Brunei Town, which was renamed in 1970 as Bandar Seri Begawan (BSB), after the 28th monarch, arguably the father of modern Brunei (Ibrahim, 1971). BSB subsequently expanded further north into the narrow valleys of the Kedayan River system (K, in Fig. 2). Yunos (2011) provides more details of the origin of Brunei and its transition to land. A close relationship between people and the environment (forest and estuaries) had been established over hundreds of years, but the arrival of the Europeans drastically altered this order. They instituted a starkly different worldview and relationship with nature, resulting in the present-day dislocated cultural characteristics and deforested and much-altered environment. The British also introduced the internal-combustion vehicle for land-based mobility. This initiated the development of road networks, cutting into the virgin forest, paving the way for urbanization, development, and deforestation. In pre-modern times, rivers were the highways for the transport of people and goods; they facilitated trade and exploration.



Note: The blue area in the LIDAR image shows low-lying areas susceptible to flooding. K indicated the main branch of the Kedayan River system.

Fig. 2. Bandar Seri Begawan and the Kedayan River.
Source: Authors (2024)

In 2009, a development masterplan was commissioned to transform BSB into a SC with a vibrant economy, and which conserves the city's natural and cultural heritage (HOK International, 2010). The Kedayan River was the central feature, which the masterplan proposed to use as the city's 'green artery'. It divided BSB into 5 action areas along the river. This study used one of them (GAC) to develop a Blue Urban plan (Fig. 3) as an example in the survey to gauge the public's response. The GAC is the 'Government Administrative Center', which houses the headquarters of several government ministries. It is highly congested during work days with traffic jams during rush hours but is a quiet area of spread-out built structures at other times. Traffic congestion occurs a few times each working day as government workers, and indeed most people with young children, have to pick up their children from one school and send them to another (religious school) in 'school runs', as well as to carry out various family obligations. The masterplan proposes a multi-modal transportation system, which includes a relatively short length of light rail transit (LRT) that would connect key high traffic areas from the international airport to the GAC, shopping centers, the national hospital, and historic parts of BSB and the Water Village. However, the LRT was deemed too costly to develop and the proposal was shelfed. However, the Kedayan River also connects the same populated areas by water.

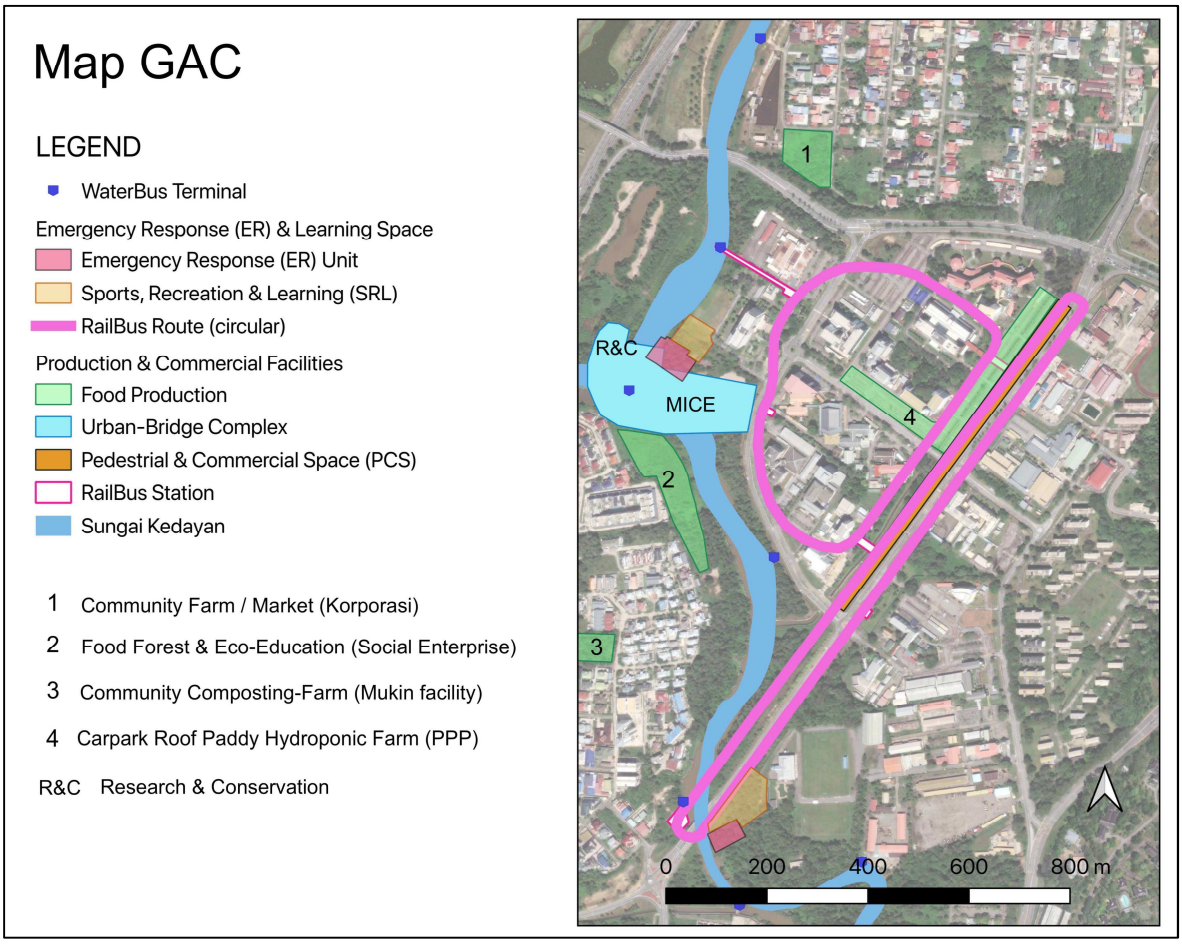


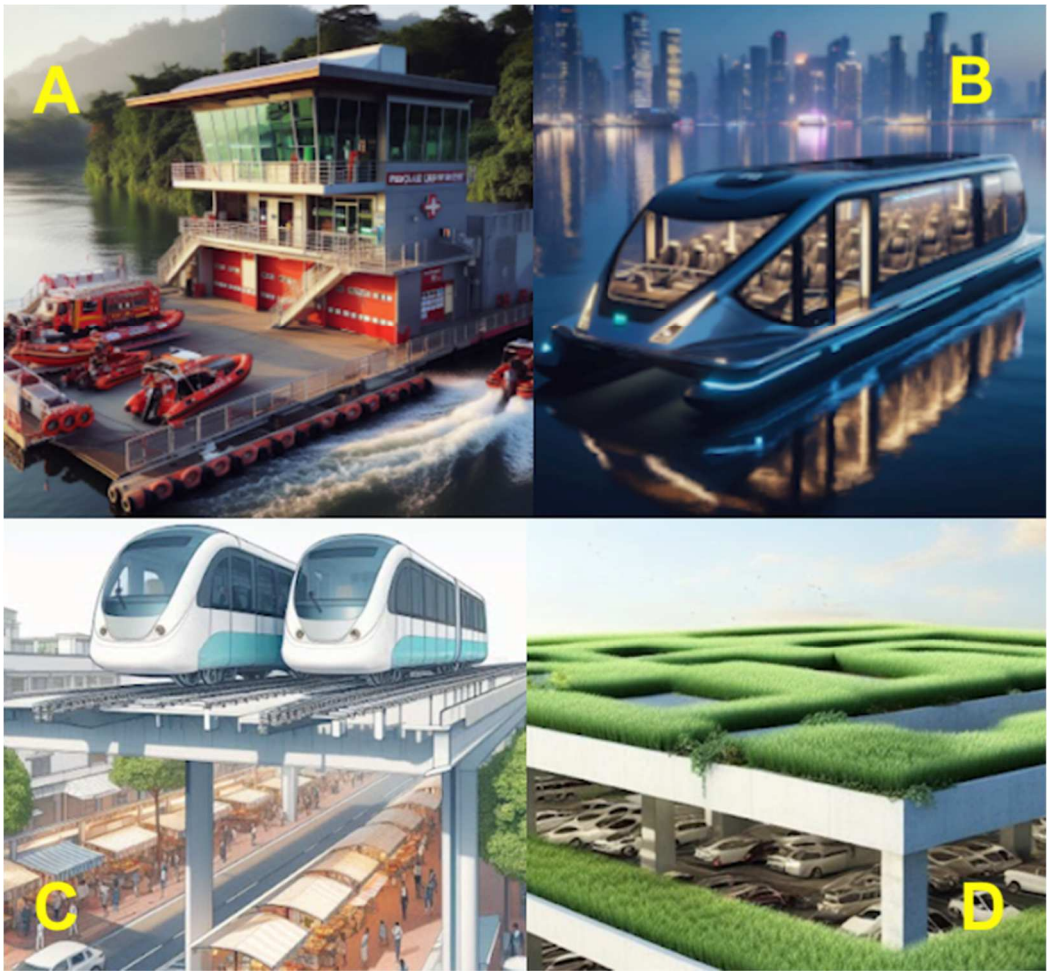
Fig. 3. GAC Urban Plan.
Source: Authors (2024)

The following were Blue Urban features used in the design of the GAC plan and survey questionnaire.

1. Prioritize water transit, which should be supported by a safe, convenient, and sheltered terminal that provides essential services to commuters.
2. Use of floating platforms in riparian zones and low-lying areas, which could rise with SLR and extreme sea level and flood events, and therefore, resilient to them.
3. Tap rainwater for local, distributed water supply for potable use and irrigation.
4. Design urban structures to capture natural light, provide shade from heat, and harness natural ventilation.
5. Use compact, vertical structures for efficiency and sustainability.

6. Use integrated multiple functional facilities and spaces to enhance efficiency and reduce waste/wastage.
7. Integrate food production into the urban complex.
8. Install recycling facilities in areas where wastes are generated, such as residential and commercial areas.
9. Use low-energy, lightweight public transit systems to facilitate mobility in urban space.
10. Create a social-cultural space to support community life and interaction.
11. Install monitoring systems to manage security, energy use, and waste generation.
12. Install emergency response services that are readily accessible to the public.

The questionnaire was created using Google Form. Invitation to participate was sent to university students and acquaintances in government agencies on 15 October 2023 without using any particular research sampling strategies in this exploratory stage. The questionnaire has four sections. The first was designed to gather details of respondents (age, sex, belief in climate change, and proximity of residents to the coast). The second asked students if they agreed/liked, strongly agreed/liked, or negative, or 'don't know, don't care', in response to 20 urban designs to improve climate resilience. The third section asks for their views (favorable versus concerned) regarding the increasing digitalizing world in 5 situations. It included two open-ended questions on (i) services/facilities that they would like in future BSB, and (ii) main concerns regarding the future. The last section surveys their level of like/dislike on 15 features of the GAC plan presented (Fig. 3) using the same 5-level Likert scale. Details of the questions asked are shown in Tables 1-5. Fig. 4 shows examples of images used in the survey to give the respondents some guidance on what was meant in the survey questions. The question on water taxis is not supported by any image to compare the respondents' view concerning their use [v] versus better-designed options, such as the water bus, which the public has never seen (see Fig. 4(B)).



(A) Emergency response station. (B) Water Bus. (C) Pedestrian walkway and sidewalk commerce beneath Rai Bus Track. (D) Car park Rooftop paddy farming.

Fig. 4. Some images used in the survey.
Source: Authors (2024)

III. RESULTS AND DISCUSSION

The survey gathered a total of 41 responses over 10 days, of which 51.2% were in the 18-25 years old age bracket. The next largest group was 46-60 years old (17.1%), followed by 26-35 years old (14.6%), 36-45 years of age (9.8%) and under 18 years old (7.3%). There were slightly more females (58.5%) than males. In response to their level of concern about climate change, 43.9% were "very concerned", 31.7% were "concerned", 17.1% were "not concerned" because the "effects will be after their lifetime", and 7.3% were "not concerned" because "technology can address it". Concerning living close to the coast, more than half (58.5%) said "no", while 9.8% indicated that they live near the sea and another 9.8% close to large rivers. The remainder (14.6%) were unsure. Brunei is a coastal country (Yong, 2010), where the majority live in the low-lying river valleys and coastal plains. However, many are unaware of the proximity to the sea and the impending threat of sea level rise.

A Results

The two results that are most telling are (i) Mean (M) and Standard Deviation (SD); and (ii) the proportion of respondents that agree/like the feature/space (third column in the tables), compared with those that do not (fourth column) or do not care (last column). M provides a representative response based on every individual's response, while SD is the range of the majority (around 2/3) of the sample. M value of, e.g., 1.2, indicates that the group, and therefore the 'public' (if the sample was sufficiently representative), more than agree/like, but only slightly more. If SD were 0.6, that means the views of the majority ranged from 0.6 (in between don't know/care and agree/like) to 1.8 (quite strongly agree/like). A small SD indicates that the majority share similar views/preferences, while a large value, quite diverse views/preferences. A high percentage in column 3 would indicate strong support, and the converse if it is low. This interpretation applies to Tables 1, 2, 4, and 5. Table 3 compares positive or negative views of specific digitalization of services, if implemented. The former is indicated by a positive M while the latter, is a negative one. High values in column 3 indicate support while low values, the converse.

Tables 1 and 2 show the results of the survey on urban services and spaces based on the model developed. Scores on -1 and -2 were grouped into "<0", while 1 and 2 were grouped as ">0". "0" are those who 'don't know, don't care'. The services (Numbers (N) 1-4) with over 90% support and M>1 (more than just agreeing to these proposals) are recycling, security, and multi-mode transit systems. In particular, there is a demand for hard facilities and infrastructure that could provide such services, including e-waste recycling, where there are campaigns but not facilities, even in advanced industrialized countries. The only opposition (5%) is against the surveillance system, perhaps because some people place high priority over their privacy. Following closely behind are recycling facilities for food and yard wastes (85% in agreement), of which the average Bruneian household generates large amounts daily. The ecologically logical solution would be to recycle them back to the Earth from which they came. Instead, the modern practice is to collect and dispose of them in landfills, where they would consume valuable land and lock away minerals that could benefit organisms. Together with rainwater harvesting (80% agree), these reflect interest in engaging in ecological practices. A small group (7%) did not agree to have food and yard waste recycling facilities close to residential and commercial areas. This could be due to the perception that they could become eye sores or cause a bad smell in the neighborhood; cleanliness, order, and clear separation of space for 'clean' and 'dirty' functions are important to some people.

Table 1: Feedback on Proposed Urban Services

No	Services	Mean	STDEV	>1	<1	0
1	Recycling facilities/services to be provided close to residential and commercial areas.	1.3	0.6	93%	0%	7%
2	Electrical and electronic waste collection and recycling services.	1.3	0.6	95%	0%	5%
3	An urban surveillance network (cameras) to enhance safety and security in BSB	1.3	0.8	93%	5%	2%
4	Multi-mode public transit network that facilitates movement and transport of things within BSB.	1.2	0.6	90%	0%	10%
5	Food and yard waste composting facilities/services to be provided close to residential and commercial areas.	1.2	0.9	85%	7%	7%
6	Rain water harvesting to be an integral part of the urban structure.	1.2	0.7	80%	0%	20%
7	Access to services to help with using digital public or commercial services.	1.0	0.9	83%	5%	12%
8	More automated services, e.g., via apps, provided by government agencies and the private sector.	1.0	0.8	83%	5%	12%
9	Regular water bus services (air-conditioned) between Kg Ayer, Gadong and BIA to be a transport option.	0.7	1.1	76%	17%	7%
10	Water taxis as an option of transport between Kg Ayer to Gadong, Berakas, Old Airport and the present airport (BIA).	0.6	0.9	71%	12%	17%

Source: Authors (2024)

The last four services received less enthusiastic support. N7 and N8, which are only increasing digitalization and access to assistance in their usage received the same proportion of support (83%) as well as negative (5%) and indifferent (12%) responses. Increasing digitalization of services is an inevitable process that cannot be stopped. It is reshaping and redefining cultures and worlds. It also alienates the older generations, many of whom struggle to operate devices, and apps and navigate the interfaces. As the respondents are largely from the younger generation, this figure is likely to be skewed in favor of the young. N9 and N10 proposed the use of waterways for transit. It is interesting to note the lower enthusiasm for the use of water taxis or water buses (71-76 % agreeing; 17% disagreeing). This could be due, in part, to their experience of riding the water taxis that currently operate in the BSB waterways. Getting wet and dirty from water spray and sweat from even a short trip is not ideal for going to the office, and social or official activities. Moreover, the water taxis and the jetties, in their current form, are not constructed with adequate safety measures.

Referring to response on urban spaces (Table 2), it is noteworthy that public spaces where one could learn about the country's history through stories and performances received overwhelmingly positive feedback (mean 1.4; 98% in support). Public spaces where people could share knowledge and skills (N3) received similarly positive feedback and support, albeit at a slightly lower level. Public performance spaces (music, dance, art, etc.) have less support. The feedback is mixed, from indifferent to strong, with 83% in favor. The same proportion opposes all of the proposed public space use. The general widespread support for public spaces for cultural activities, in particular, heritage conservation (N1), is an interesting insight into the respondents' interests and priorities. If they are indeed representative samples of the populace, such spaces should be included in urban plans and development. N2 and N4 are proposed designs that address environmental quality and sustainability. They are similarly positively received, with sheltered urban space and natural ventilation better supported (88%, M 1.2). Interestingly, 7% have an unfavorable view of this design. Further study is needed to understand the reason. N6 and N9 serve a dual purpose of gauging (i) affinity for the river, a feature of traditional culture, and (ii) preparedness for higher sea levels. They are met with mixed responses, with lower support for floating spaces (68%) than waterfront bazaars (83%) and negative responses from 22% and 7% respectively. N7 and N8 are sustainable design concepts, the former converting unused spaces and

rooftops to food production spaces, while the latter proposed compact, walkable, vertical urban structures for more energy-efficient lifestyles. They received the same combination of mixed responses as 6 and 9, but overall positive.

Table 2: Feedback on Urban Design.

No	Urban Design	Mean	STDEV	>1	<1	0
1	Public spaces where people could share/learn about Brunei's past through stories, music and other performances.	1.4	0.7	98%	2%	0%
2	Urban structures (buildings, alley ways, walkways, etc.) to be sheltered from sun and rain and designed to tap natural circulation for ventilation and cooling.	1.2	1.0	88%	7%	5%
3	Public spaces where people share knowledge and skills and offer short courses.	1.1	0.7	93%	2%	5%
4	Buildings to have monitoring system that display the energy used or overused, and amount of waste generated.	1.0	0.8	83%	2%	15%
5	Public spaces for creative expression through music, art, dance, etc.	1.0	1.0	83%	7%	10%
6	More waterfront bazaars and social gathering spaces along Sg Kedayan.	1.0	0.9	83%	7%	10%
7	Food production (commercial vegetable, fruit, flowers, eggs, etc.) in un-used spaces and rooftops.	0.9	1.1	80%	17%	2%
8	Compact and vertical city, so that many places are reachable by walking or public transit.	0.7	1.1	68%	20%	12%
9	Floating commercial and public spaces attached to river banks.	0.7	1.3	68%	22%	10%

Source: Authors (2024)

The survey results for urban services and space use suggest a demand for more convenience and 'green' designs, which are commonly promoted as sustainable practices in environmental education. Although the majority would like to see more integration with natural flows, such as rainwater harvesting and natural ventilation, or direct use of renewable resources, there are greater interests in social-cultural spaces, in particular, to facilitate heritage conservation. An interesting finding is the response to the question on the respondents' willingness to accept the higher cost of transitioning to a more sustainable future because it will be cheaper in the long term (not included in the tables). The majority (82.9%) indicated "yes", while 19.5% "strongly" agreed to it. Only 9.8% disagreed while 7.3% did not decide one way or the other. The overall response (M 0.9, SD 0.9) suggests that there is just a positive inclination. There is a less positive response for more integrated designs. This is probably because it requires a deeper understanding of ecological architecture that many of the respondents are unlikely to have.

Table 3: Feedback on Digitalization Services

No	Digitalisation of Services	Mean	STDEV	>1	<1	0
1	You can get your daily provisions through an app service.	1.22	0.76	85.4%	2.4%	12.2%
2	Transport services are integrated, such that you can switch from water bus, water taxi, rail bus, public bicycle, or ride sharing (e.g., DART) and payment can be made through an app.	1.17	0.92	80.5%	7.3%	12.2%
3	Government/Public services and systems are to be digitalised, requiring smart phone/device, email accounts and passwords.	0.76	1.07	70.7%	17.1%	12.2%
4	Welfare services are provided through digital system requiring the use of smart devices or kiosks.	0.71	1.08	70.7%	19.5%	9.8%
5	Commercial services, including eating in café and restaurants, require smart devices, use of QR code, etc.	0.27	1.34	46.3%	41.5%	12.2%

Source: Authors (2024)

With regards to the increasing digitalization of services (Table 3), there was favorable feedback on being able to obtain daily provisions through an app (M 1.2, 85.4% in favor) and integrated transport payment (M 1.2, 80.5%). Smart city living has been identified as a means to achieving sustainability. The response to the increasing digitalization of public services, welfare services, and commercial services were all only slightly positive, probably due to current experiences of such services, which are complicated, problematic, and not easy to use. Furthermore, most of the older generation (above 45 years old) struggle with using apps and QR codes. The mixed response is evident in the equal proportions of support and concern with increasing digitalization of commercial services (N5). The proportion for government (N3) and welfare (N4) services is more skewed toward those who view it favorably by about 4:1. Although the digitalization process will continue, inevitable exclusion of the older segment of the populace must be addressed; the young people in this business sector appears to be unaware of this issue. There is a need for effective integration of human well-being, social landscapes, and the built environment to create sustainable living in smart cities (Chen, 2023).

The GAC is an important part of BSB. Its current design is spread out and separated from important urban services. It is characteristic of modern industrial design but is monofunctional, in this case, the center of government. Although there is a river close by, it is not used. Access is by road, which requires large areas for parking, a land use that has a significant effect on local climate and storm runoff. The GAC urban plan used in the survey included water transit (waterbus and water taxi) and rail bus to facilitate mobility; the former also connects the area to other parts of BSB along the Kedayan River and its tributaries. Each jetty and terminal are sited to facilitate movement without the need for private vehicles. It also tried to integrate mixed-use spaces and facilities, such as an urban complex-cum-bridge, parking space roofing-paddy cultivation, commercial space-pedestrian walkway beneath the elevated rail-bus track-roof (Fig. 4(C)), and recreation-learning space adjacent to the emergency response (ER) facility (see Fig 4(A)), where the public could also learn ER skills. The plan also included food production spaces (farms) that are integrated with the urban structure, nearby communities, food waste recycling, and green space (food forest).

The overall response on whether the plan should be implemented (not shown in the tables) is strongly positive (M 2.2 out of a maximum of 3.0, SD 0.8). For 41.5% of the respondents, it is affirmative (Yes, definitely), while 39.0% would like some changes, and 19.5% a lot of changes. No one chose to retain the status quo, which suggests the current design is not popular. Table 4 shows the feedback on services and space in the GAC plan. Having ER stations and public space to learn about safety and ER in addition to sports and recreation appears to be quite desirable (over 93%, M 1.5 and 1.3 respectively). Only 5% did not like the idea. The inclusion of a community eco-education food forest and a community co-op farm in the vicinity received similar responses (M 1.1, 85% in support, but with slightly higher variability for the former). A small group did not like the plan for food forest (5%) and community co-op (2%). The last two received mixed responses. Although still somewhat favorable (about 70% in support), there was a larger proportion (about a quarter) that had no view or interest. This is probably due to a lack of interest in nature conservation, research work (N4), and or conference/ exhibition (N5) spaces among the group.

Table 4: Feedback on GAC Services & Design.

No	Services & Spaces	Mean	Stdev	>1	<1	0
1	Do you like the idea of having Emergency Response (ER) stations in case of accidents in the river or during floods?	1.5	0.8	95%	5%	0%
2	Do you like the idea of having a public space for sports, recreation and learning (SRL) about safety and emergency response conducted by emergency response personnel?	1.3	0.6	93%	0%	7%
3	Do you like the idea of having a 'food forest' as a community farm and ecological education facility?	1.1	0.9	85%	5%	10%
4	Do you like the idea of a community farm/co-op to provide food and additional income for the Burong Pinggai area?	1.1	0.7	85%	2%	12%
5	Do you like the idea of Research & Conservation facilities at the urban-bridge complex?	1.0	0.8	73%	2%	24%
6	Do you like the idea of having a meetings, incentives, conferences and exhibitions (MICE) space in the urban-bridge complex?	0.8	0.9	68%	7%	24%

Source: Authors (2024)

The results of the survey on mobility and integrated spaces (Table 5) reveal enthusiasm for the use of the rail bus. The fact that there is a link to a video [vi] promoting the railbus is likely to have influenced the decisions of many. The suggested route for the railbus, however, received less favorable responses (M 0.8, 66% in support, 10% disliking). This could be because the GAC is only part of the whole government administrative area, which extends further out of the BSB boundary. It would be better if there were links to the rest of the government complex. The idea of using a building to double as a bridge was also viewed favorably. The feedback was however much more varied with 90% in favor, 5% not, and 5% indifferent (M 1.2). The feedback on the use of waterbus was already only slightly positive (Table 1, N9). There was much indifference (32%) regarding waterbus terminals; negative feedback accounted for 17%. The view is only slightly favorable from about half of the respondents. The terminal inside the building-cum-bridge received a better response.

The response to locating a farm recycling facility within a residential area, an unused space, is positive but muted (M 1.1, 80% in support, 7% dislike). It is interesting to note that the feedback on more unconventional integrated designs, such as installing a rooftop farm for the large area of open parking space in the GAC (Fig.4 (D)), and utilizing the space below the railbus as a pedestrian walkway and market also the sides, were less favorable (56-61% liked, 22-29% disliked, 15-17% didn't care). Although there was more positive than negative feedback from the survey, there appears to be less support or likes for more integrated, ecological designs. This reflects the mindset of the respondents. Further research is needed to better understand responses that do not make sense from an environmental stance.

Table 5: Feedback on GAC Mobility & Integration of Spaces.

No	Mobility & Integration	Mean	STDEV	>1	<1	0
1	Would you be willing to use a railbus to get around the GAC?	1.5	0.6	98%	2%	0%
2	Do you like the idea of a using an urban complex as a bridge?	1.2	0.8	90%	5%	5%
3	Do you like the idea of having an indoor Waterbus Terminal in the bridge complex?	1.1	0.9	83%	7%	10%
4	Do you like the idea of having a Farm-Recycling facility in a residential area?	1.1	0.9	80%	7%	12%
5	Is the Railbus route adequate for mobility in GAC area?	0.8	1.0	66%	10%	24%
6	Do you like the idea of an urban paddy cultivation facility above the parking space at GAC?	0.6	1.1	61%	22%	17%
7	Are the terminals for waterbus adequate?	0.4	0.9	51%	17%	32%
8	Do you like the idea of having a pedestrian-commercial space (PCS) below and along the railbus route?	0.4	1.3	56%	29%	15%

Source: Authors (2024)

B Discussion

The survey findings revealed that the main feature of Blue Urbanism, i.e., use of the river for transport and connecting with other key areas of BSB is met with muted interest, despite the fact that (a) travel time would be shorter during rush hours, and (b) a futuristic comfortable water bus was presented in the questionnaire to give them a sense of the comfort, safety, and technologically advanced nature of the service offered. This does not bode well for a Blue Urbanism adaptive strategy to embrace a future world where water is expected to be more prominent in the environment. The saving grace is that three quarters of the respondents are opened to it. Other aspects of Blue Urbanism, such as integrating multi-functional complex with the river as bridge and waterbus terminal is met with slightly better response and by about 90% of the respondents, i.e., high majority. In general, there appears to be a lack of 'eco-literacy' [vii], which is required to appreciate compact, complex, and self-organizing system that is characteristics of nature (Pasquero & Poletto, 2012; Soleri, 1969; Yong, 2022). Instead, the respondents are more inclined to support 'green' practices that are taught in environmental education and campaigns, such as recycling, rain-harvesting and multi-modal transit systems. While these are also important, it suggests much work is need to prepare the Brunei population for this adaptive strategy.

For much of its history, Bruneians lived primarily in a water (estuarine) environment, adapting completely to this life over water (Blundell, 1923). Presently, many of those residing in the water village

prefers to remain despite the many difficulties faced and higher expenses in maintaining their house than their counterparts on land (Hassan et al., 2022). Indeed, Brunei is a coastal state, and the Sultanate was a thalassocracy for much of its existence. There is therefore an affinity for the water environment, whether it is the river, estuary or ocean. It is interesting that less than a century on land has altered the culture and shared lived world of the citizenry from water to land, and for the younger generations, indoors and air-conditioned, and partly, also virtually in electronic media. This is truly a dislocation caused by modernization (Yeoh, 2021). Interestingly, the majority of respondents would like more public spaces, where they could learn about their heritage through stories and performing arts – a combined interest in cultural heritage and the arts and entertainment, so important to social vibrancy. This is the human side of the eco city coin. Following the remarks made by Sadowski (2023), this presents an opportunity to integrate more cultural conservation spaces, as people are more inclined to embrace familiar systems than new foreign ones. Perhaps, these urban spaces could support the development of a heritage-arts industry (Azrein & Yong, 2022), which could bring about social and economic vitality, and meet the objectives of the BSB masterplan on heritage conservation and economic vibrancy.

The views on ER and opportunity to learn ER skills and participate in real situation is a distinct cultural trait of the Bruneian that is familiar to insiders. A people-centered urban design (Gehl, 2010) that allows for public participation in the life and management of the city would sit well for Bruneians. From an urban ecology perspective, an organic, i.e., less controlled, planned and policed, city would be a happier one, because the ecosystem could interact freely, and be vibrant and innovative, important driving factors in the development and growth of cities. However, current trend in digitalization threatens to marginalize the older and less financially secured segments of the society from the benefits of the SC. Digitalization is an unstoppable process, and deliberate efforts need to be made to ensure inclusion of the marginalized, perhaps through enabling or helper services, preferably involving human beings.

IV. CONCLUSION

The paper posits that a Blue Urbanism approach would be a more viable response for coastal cities in the humid tropical region to CC. The arguments for this case are as follows:

1. The impact of CC in this region would primarily be manifested in increased flooding from a combination of higher rainfall and SLR, as well as higher frequency of extreme atmosphreic and oceanic events. This would usher in a world where water is a prominent feature in the urban environment.
2. Modern engineering and management (grey) approachs are costly and require techical capacity that many, particularly less-developed, coastal cities do not posses. Preparing only to cope may be prudent, but it leaves denizens on the edge with uncertainties and potential for loss and damage. A proactive response would be to embrance the future reality, since the confidence associated with scientific prediction (e.g., by IPCC WG1) is quite strong.
3. A Blue Urban strategy simply means embracing the water environment. Beatley's concept is a strongly ecological one, which is shared by other such schools of sustainable/ eco cities, and include BGI and BGGI.
4. Beatley's Blue Urbanism would enhance connection between people and environment, and allows for more ecological, people-centred city, with good awareness of the environmental integrity and symbiotic existence between people and the environment.
5. Although the survey found a departure of the younger generation from the blue urban culture of old, this could be rectified, particularly, as there is strong interest to learn more about the country's heritage and to participate in its development.

Although this option might makes sense for Brunei, due to its history and geography, many coastal cities could benefit from insights from the Brunei case, particularly if they consider similaity in conext. The research however is in its early stage with responses from a small sample. The findings presented are preliminary. Further work is needed to improve understanding of the situation, such as responses that are not logical from an ecological perspective. However, there is enough to suggest that a Blue Urbanism strategy is a viable response to CC. For Brunei, it will be like a return to its recent past - a familiar world but updated in terms of ecological knowledge and technology.

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